DOCUMENT RESUME

ED 186 261 SE 030 650

AUTHOR Capie, William: And Others
TITLE Using Science Achievement to Validate Student Teacher Competencies.
PUB DATE Apr 80
NOTE 26p.: Paper presented at the Annual Meeting of the National Association for Research in Science Teaching (53rd, Boston, MA, April 11-13, 1980). Contains light and broken type.

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS Academic Achievement: *Competency Based Teacher Education: Educational Research: Elementary Education: *Elementary School Science: *Preservice Teacher Education: Science Education: *Science Instruction: *Student Teachers: Teacher Effectiveness: Tests

ABSTRACT

Reported is a study to determine the validity of competencies which are the basis of professional teacher certification. The paper also assesses the importance of generic competencies in science learning at the elementary level. The study itself offers several recommendations regarding teacher training and research in classrooms using instruments similar to the Teacher Performance Assessment Instruments (TPAI). It suggests that management is an important factor in achievement in elementary classrooms where student teachers are involved. (Author/SA)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED186261

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

William Capie

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

USING SCIENCE ACHIEVEMENT TO VALIDATE STUDENT TEACHER COMPETENCIES

William Capie
Kenneth G. Tobin
Margaret Bowell

Department of Science Education
University of Georgia
Athens, Georgia

Paper Presented
at the
National Association for Research in Science Teaching

Boston
April 12, 1980

SE 030 650

USING SCIENCE ACHIEVEMENT TO VALIDATE STUDENT TEACHER COMPETENCIES

The quest for valid teacher competencies is certainly not a recent phenomenon. Although current interest in competency- or performance-based teacher education can be attributed to the development of the model teacher education programs of the late nineteen-sixties, interest in teaching competencies can be traced back much further. Beginning in 1926, for example, W. W. Charters and Douglas Waples (1929) attempted to identify, as comprehensively as possible, the duties and traits of teachers so as to determine systematically what teachers should be taught. They did indeed do comprehensive analysis of teacher duties, identifying 236,655 specific statements of teacher activity. These were partitioned into divisions, subdivisions, sections and subsections.

In the years since the model program activity development, activity has been widespread and diverse. Controversy grew to the point where The Science Teacher featured an article titled "To Have or Not to Have Competent Teachers is Not the Question!" (Yarger, 1974) While teachers, professional organizations and others debated the merits of competency-based education and competency-based teacher education and even specific competencies, the research community was called on to lay a new foundation for teacher education. Chided because no ready answers existed to the question of "what is competence?" researchers were asked to formulate plans for validating competencies.

At least two types of reactions to the debate can be identified. The research community has been able to identify certain principles of instruction which appear to be related to desirable student outcomes.

(See for example, Hoge and Luce, 1979; Gage, 1979; Rosenshine, 1978)

In the socio-political community, legislators also became caught up in the push for competency. Mandates moved some states toward competency assessment, if not competency-based teacher education. Georgia is the one state where movement to full scale implementation is nearly complete. A comprehensive competency-based certification plan has been developed and the final stages of implementation are underway. Prospective teachers must demonstrate subject area proficiency on a criterion referenced test before initial certification. Similarly, state approved teacher education programs must make provisions for assessing a number of competencies during the senior internship. Finally, three year provisional certificates can be renewed only by demonstrating satisfactory performance on two consecutive classroom performance assessments.

The Teacher Performance Assessment Instruments (TPAI) (Capie, W., Johnson, C., Anderson, S. J., Ellett, C. and Okey, J., 1979) have been developed to facilitate the performance assessment of provisional and student teachers. The current edition is designed to assess 14 competency areas such as planning, evaluation, instruction and management through ratings on 45 performance indicators on a 5-point scale. The Teacher Assessment Project has been commissioned by the State to develop instrumentation and organize the research studies to support the use of the instruments in certification. The nature of the instruments and their development are described in numerous project publications and other sources. (See for example, Okey, J. and Capie, W., 1980)

An overriding legal concern in the development efforts has been establishing the validity of the TPAI and the underlying competencies as they relate to effective teaching. Many validation approaches are

possible, each with its particular merits. For example, expert testimony is an area where the courts are traditionally quite responsive. Also, factor analyses have suggested a single construct underlying the TPAI. Yet, the single validity criterion that remains most noteworthy is the relationship of teacher competencies or performance measures to desirable pupil outcomes. In the context of teacher effectiveness research, student growth or similar measures of change are the most reasonable outcome variables to consider. Consequently, this study was planned to address important validity concerns by relating TPAI measures with measures of student growth.

PROBLEM

The purpose of the study was to determine what portion of the variation in class mean achievement gains can be attributed to classroom performance measures of preservice teachers. Significant correlations would be suggestive of the validity of the instruments and the underlying constructs. A secondary concern was to assess the importance of these generic competencies in science learning at the elementary level.

METHODS

Twenty-five undergraduate interns in early elementary education and several hundred pupils in local schools participated in the study. Interns visited the classrooms for two days early in the first quarter of a two-quarter senior internship. They then returned to campus and prepared a short science unit for use in the schools later in the quarter. During the first full week of school activity the unit was implemented. Interns were rated on the TPAI by their science methods instructor as well as an instructor in general methods after independent observations. Pupils were pre-and post-tested on unit objectives.

SUBJECTS

Interns were two quarters from graduation and potential certification. All had spent two prior quarters in combined school and campus activity. None expressed particular interest in science although all were enrolled in a science methods course. Each had at least three prior college science courses.

Pupils were in grades K-5 in local schools where classrooms are heterogeneous with respect to race and ability in accordance with district policy. The science program in the schools is quite diverse from classroom to classroom.

The teaching units were jointly planned with classroom teacher, intern, general methods instructor and science methods instructor all providing input. Units were of five days duration and planned to articulate with the ongoing school program. Interns were asked to incorporate a process emphasis, preferably work with quantitative data, and to use several different types of learning activities in their units. Learner objectives were specified to facilitate instruction as well as test construction.

INSTRUMENTS

The Teacher Performance Assessment Instruments (TPAI) were used to assess intern performance. Three of the instruments were used in this study. The one Teaching Plans and Materials (TPM) competency assessed dealt with the objectives, materials and activities included in the unit plan. The Classroom Procedures (CP) and Interpersonal Skills (IS) instruments were used to assess eleven additional competencies relating to instructing, classroom management and dimensions of the learning environment.

The TPAI are based on the assumption that a professional competency is a complex set of interrelated behaviors. Statements which identify these skills are, therefore, general. Thus, second- and third-order descriptions of behavior are included to facilitate assessment. Indicators are second-order, sentence-length statements, scored on a scale from 1-5, which provide more detailed behavioral descriptions of teaching competencies. The more indicators a teacher demonstrates, the more likely the teacher is demonstrating the competency. Descriptors are third-order definitions of behavior which provide a means of associating teacher behavior with scale points for scoring.

The TPAI scoring procedures require each data source to rate the teacher being assessed on each indicator by choosing the descriptor (on a 1-5 scale) which best describes the teacher's behavior. Scores awarded by data sources for each indicator associated with a competency can be averaged to compute a competency score. The final score for any competency is a mean which can range from 1.00 to 5.00.

The psychometric characteristics of these instruments are well documented. High interrater agreements and internal consistency estimates are reported; generalizability coefficients are sufficient for differentiating teacher competencies ($\rho = .97$). (Capie, Ellett and Johnson, 1979: Tobin and Capie, 1980)

Pupil measures. Pupils were pre- and post-tested on instruments developed by the interns. Interns were advised to prepare objective tests which reflected their objectives. The tests were reviewed by the two instructors, and modified as needed, to ensure congruence with objectives and sound measurement practice. An effectiveness index derived from the pre- and

post-tests was the class mean of a measure called the percentage of the possible gain computed for each pupil. The difference between the post- and the pre-tests (observed gain) was divided by the difference between the maximum possible score and the pre-test score (possible gain) and then multiplied by 100 to compute the percentage of possible gain. A generalizability coefficient of .84 was found when these measures were used to differentiate classrooms. However, a value of .00 was computed when similar sets of scores were used to distinguish occasions. The properties of this index have been described elsewhere. (Safter, W., Tobin, K. and Capie, W., 1980)

ANALYSIS

Thirty-six TPAI indicators comprising twelve competencies were rated. Not all were rated by each observer in accordance with directions to omit indicators where rating would not be appropriate. In addition, factor scores based on analyses by Tobin, Capie, Ellett and Johnson (1980) were computed. All scores were available from both data sources as well as from the combination of the two.

A multiple regression of the factor scores against the teacher effectiveness index was completed. Pearson product moment correlations were computed between the effectiveness index and each indicator rating and each competency and each factor score.

RESULTS

Seventy-seven of a possible one-hundred five ratings were significantly and positively related to achievement gains. A summary table is reported in Table 1. Correlations ranged to .72 for indicators (science instructor's

(Include Table 1 About Here)

TABLE 1

Correlations Between Teacher Ratings
and Pupil Achievement Gains in Science

First Occasion	Science Instructor	College Supervisor	Combined Ratings
Number of Indicators Rated	31	32	33
Number of Significant Correlations	17	13	19
Number of Competencies Rated	11	11	11
Number of Significant Correlations	9	4	9
Number of Factors Rated	2	2	2
Number of Significant Correlations	2	2	2

ratings of IS 3, "Demonstrates Warmth and Friendliness"), and to .66 for competencies (science instructor's ratings of Competency 14, "Helps Learners Develop Positive Self-Concepts"). A complete listing of indicator correlations for individual and combined data sources is included as Table 2. A complete listing of competency correlations for individual and combined data sources is included as Table 3.

(Include Tables 2 and 3 About Here)

When factor scores were correlated with mean achievement gains significant correlations were found in each case. Values ranged from .5 to above .6. In all cases, the multiple regression improved prediction only slightly beyond that of either factor considered alone. Complete data are contained in Table 4.

(Include Table 4 About Here)

DISCUSSION

The results were viewed as supportive of the competencies assessed by the Teacher Performance Assessment Instruments (TPAI). While significant correlations have been more numerous in studies involving beginning teachers, the magnitude of these correlations is greater. (See Capie, Ellett and Johnson, 1980: Ellett, Capie and Johnson, 1980.)

The similar correlations between achievement gains and both the Management and Learning Environment factors were somewhat surprising. Typically, management is not an area which is given great attention in science methods, yet Management and Learning Environment appear highly correlated and related to class achievement gain, as well. Five of the seven indicators which were significantly correlated with achievement for both data sources related to Management (CP 5, 14, 18 and 19 and IS 8). Other than "maintaining student involvement in

in learning tasks" (on-task behavior or engagement) (CP 14), there are few surprises in the management indicators. Handling materials and managing routines in the classroom CP 18 and 19) as rated by both observers are important predictors of achievement. One interesting predictor which relates to management is "clarifies content when learners misunderstand" (CP 5) which correlated with achievement for both raters.

The two learning environment indicators which were significantly correlated for both data sources were "gets learners initially involved" (CP 13) and "personalizes lessons for students" (IS 2). Both of these indicators also reflect elements of classroom management.

The competency "demonstrates an understanding of the school subject being taught" was significantly related to achievement only when the ratings of the generalist were used as a predictor. Curiously, the ratings of the science specialist failed to replicate this finding. Assessing subject area competence in the classroom has generated a great deal of debate in Georgia where a criterion referenced knowledge test already exists for most certification areas.

Many of the non-significant correlations are of the same magnitude as those reported among beginning teachers. Ellett, Capie and Johnson (1980a,b) have reported several replications of studies where significant correlations on the order of .3 have been found with large numbers of beginning teachers. Thus, the failure to replicate significant findings here may be a question of power.

The five planning indicators did not predict achievement. This finding may be explainable by the high quality of unit plans prepared as a major part of a grade in two college courses! In a study of secondary students, the planning dimension included the strongest predictors of achievement gains. (Capie, Ellett and Johnson, 1980)

A number of methodological and contextual factors might help to account for the results obtained. Using two raters across all interns provided a means of maintaining reliability in the measures. This factor can best be appreciated in examining the correlations of competency scores and achievement. In many cases the correlation of the combined raters is greater than that obtained for either rater independently. The competency is to be the unit of decision-making as the TPAI are used for certification. This same phenomenon does not occur among the indicator ratings which tend to be more variable or among the factor scores which are more stable. These data suggest that if factor scores are to be used, perhaps for staff development, one rater may be sufficient.

The levels of correlation in this study are somewhat higher than what Gage has claimed to be a reasonable expectation (1979). This finding may have occurred because several aspects of the teaching similar types of lessons to similar types of students in two similar schools. The length of the units was controlled, as well. Because the students were quite inexperienced, true variation in the teaching performance would be expected to have been maximized. This range of performance may have enhanced the possibility of finding significant correlations. One problem that always exists in process-product studies of this type is identifying a range of teaching behaviors, particularly on the lower end of the scale.

The student outcome measures were controlled so that reliability was maintained. Although gain scores are suspect when students are used as the unit of analysis, the class means were much more reliable in this study (.84 as compared to .3). The particular gain score to be used in studies like this one is an issue that needs further attention.

IMPLICATIONS

This study suggests several recommendations regarding teacher training and research in classrooms using instruments similar to the TPAI. Most prominently, Management is an important factor in achievement in elementary classrooms where student teachers are involved. More attention might well be given to this area in teacher training, particularly in science where there are many transitions, materials and other potential distractions.

This study illustrates that when many sources of random variation in a teaching study are controlled, good results are possible. As compared with other process-product studies involving the TPAI, this one controlled the subject area, the nature of the topic, the length of the unit, the nature of the classrooms, and variation among raters. In addition, care was taken to minimize error due to the testing process. All of these factors may have contributed to the results.

CONCLUSIONS

Considerable debate can be waged in studies like this one with the question, "What is validated?". A case can be made for each of the following:

1. the underlying competencies which represent abstractions or constructs which form the basis of teacher performance:
2. the TPAI as represented by the printed pages of indicators and descriptors;
3. the TPAI as represented by the combination of the printed page and the individuals who make the ratings; or,
4. the measures generated.

Perhaps other equally strong suggestions are possible. It may be that the measures cannot be separated from the other areas or vice versa.

To the extent that validation of the TPAI requires the printed page to fall into the hands of any rater, this study falls short. Yet, it surely does provide evidence of the importance of the teaching areas defined as they relate to pupil achievement gains. Perhaps subsequent validation efforts should address as many areas of potential unreliability as possible in order to determine the potential ceiling point for teacher performance/student achievement correlations and assess the impact of error in the system in subsequent studies.

REFERENCES

Capie, W., Ellett, C. & Johnson, C. Selected investigations of the reliability of the TPAI. Athens: Teacher Assessment Project, 1979.

Capie, W., Ellett, C., & Johnson, C. Relating pupil achievement gains to ratings of secondary student teachers performance. Paper presented at the Eastern Educational Research Association, Norfolk, VA, 1980.

Capie, W., Johnson, C., Anderson, S. J., Ellett, C. & Okey, J. Teacher performance assessment instruments. Athens: Teacher Assessment Project, 1979.

Charters, W. W. & Waples, D. The commonwealth teacher survey. Chicago: The University of Chicago Press, 1929.

Ellett, C., Capie, W. & Johnson, C. Teacher performance and pupil perceptions of the social environment to learning. Paper presented at Eastern Educational Research Association, Norfolk, VA, March, 1980a.

Ellett, C., Capie, W. & Johnson, C. Teacher performance and pupil achievement on teacher made tests. Paper presented at Eastern Educational Research Association, Norfolk, VA, 1980b.

Gage, N. L. The yield of research on teaching. Phi Delta Kappan, November, 1978, 229-235.

Hoge, R. D. & Luce, S. Predicting academic achievement from classroom behavior. Review of Educational Research, 1979, 49: 479-496.

Okey, J. & Capie, W. Assessing the competence of science teachers. Science Education, in press.

Rosenshine, B. Instructional principles in direct instruction. Paper presented at AERA meeting, Toronto, 1978.

Safter, W., Tobin, K., & Capie, W. An empirical analysis of teacher effectiveness indices based on class mean change scores. Paper presented at Eastern Educational Research Association, Norfolk, VA, 1980.

Tobin, K. & Capie, W. Application of generalizability theory to teacher performance. Paper presented at Southeastern Invitational Conference on Measurement in Education, Greensboro, February 1980.

Tobin, K., Capie, W., Ellett, C. & Johnson, C. A confirmatory analysis of the factor structure of teacher performance. Paper presented at the Eastern Educational Research Association, Norfolk, VA, March 1980.

Yager, S. To have or not to have competent teachers is not the question! The Science Teacher, September, 1974, 52-53.

TABLE 2

Correlations of Elementary Student Teachers TPAI Ratings with Student Achievement Gains in a Science Unit (25 classrooms)

	Indicators	Prime[1] Factor	Ratings of Generalist	Ratings of Specialist	Combined Ratings
TPM 1	Specifies or selects learner objectives for lessons.	G	.07	.12	.12
TPM 2	Specifies or selects teaching procedures for lessons.	G	.13	-.03	.05
TPM 3	Specifies or selects content, materials, and media for lessons.	G	-.08	.25	.15
TPM 4	Specifies or selects materials and plans for assessing learners.	G	-.01	.14	.05
TPM 5	Plans instruction at a variety of cognitive levels.	G	.12	.21	.21
CP 1	Uses audiovisual and other instructional equipment.	G	-.23	.64*****++	.42+++
CP 2	Uses instructional materials that provide appropriate practice on the objectives.	G	.30	.38*	.42*
CP 3	Organizes learning activities in a logical sequence.	M	.37*	.14	.29
CP 4	Gives clear directions and explanations.	M	.23	.23	.29
CP 5	Provides directions and explanations when learners misunderstand.	M	.37*	.33*	.42*

Table 2 (Continued)

	Indicators	Prime[1] Factor	Ratings of Generalist	Ratings of Specialist	Combined Ratings
CP 6	Conveys the impression of knowing what to do and how to do it.	L	.16	.35*	.29
CP 7	Uses acceptable written and oral expression with learners.	L	.18	.33	.31
CP 8	Uses responses and questions from learners in teaching.	L	.28	.44*	.45**
CP 9	Provides learners with opportunities for participating.	M	-.07	.17	.06
CP 10	Demonstrates ability to conduct lessons using a variety of teaching methods.	L	.21	.66***	.56**
CP 11	Uses teaching methods appropriate for objectives and learners.	M	.05	.38*	.25
CP 12	Demonstrates ability to work with individuals, small groups, and large groups.	M	.23	.18	.27
CP 13	Uses procedures which initially get learners involved in lessons.	L	.38*	.42*	.48**
CP 14	Maintains learner involvement in lessons.	M	.51**	.58**	.62***
CP 15	Demonstrates knowledge in the subject area.	L	.41*	.25	.38*
CP 16	Presents accurate information about the topic being taught.	L	.39*	.16	.26

14b

TABLE 2 (Continued)

	Indicators	Prime Factor	Ratings of Generalist	Ratings of Specialist	Combined Ratings
CP 17	Provides learners with information on the purpose and importance of topics.	L	.33*	.23	.33*
CP 18	Attends to routine tasks.	M	.49**	.52**	.55**
CP 19	Organizes materials for efficient use by learners.	M	.39*	.45*	.48**
CP 20	Provides a learning environment that is attractive and orderly.	L	.79*+	--	.76*+
CP 21	Uses special or unexpected events to supplement lessons.	M	--	--	--
CP 22	Makes modifications in lessons as needed.	M	--	--	.89**++++
IS 1	Communicates personal enthusiasm.	L	.10	.26	.19
IS 2	Communicates with learners in a way that conveys interest in them and in the subject.	L	.38*	.50**	.53*
IS 3	Demonstrates warmth and friendliness.	L	.23	.72***	.60***
IS 4	Demonstrates sensitivity to the needs and feelings of learners.	L	.24	.40*	.49**
IS 5	Demonstrates patience, empathy, and understanding.	L	--	--	--
IS 6	Provides feedback to learners about their behaviors.	M	.60***	.05	.56**

TABLE 2 (Continued)

	Indicators	Prime[1] Factor	Ratings of Generalist	Ratings of Specialist	Combined Ratings
IS 7	Promotes comfortable interpersonal relationships.	M	.16	.40*	.30*
IS 8	Manages disruptive behavior among learners.	M	.63***	.45**	.5[illegible]***
IS 9	Maintains appropriate classroom behavior.	M	.33	.53**	.53**

[1] Factor Designations are as follows: G = General Teaching Effectiveness: L = Learning Environment; M = Classroom Management.

*p ≤ .05

**p ≤ .01

***p ≤ .001

$^{+}N = 10$

$^{++}N = 12$

$^{+++}N = 16$

$^{++++}N = 6$

TABLE 3

Correlations of Elementary Teachers TPAI Competency Ratings with Student Achievement Gains in a Science Unit (25 classrooms)

Competency	Generalists Ratings	Specialists Ratings	Combined Ratings
1. Plans instruction to achieve selected objectives.	.06	.17	.14
2. Organizes instruction to take into account individual differences among learners.	--	--	--
3. Uses instructional techniques, methods, and media related to the objectives.	.32	.36*	.41*
4. Communicates with learners both orally and in writing.	.29	.42*	.41*
5. Reinforces and encourages the efforts of learners.	.14	.34*	.30
6. Demonstrates a repertoire of teaching methods.	.24	.52**	.47**
7. Uses procedures which involve the learner in the instruction.	.51**	.58**	.62***
8. Demonstrates an understanding of the school subject being taught.	.55**	.21	.42*
9. Organizes time, space, materials and equipment for instruction.	.51**	.56**	.61***
10. Adjusts instruction to changes in conditions.	-.50+	--	.86***+

TABLE 3 (Continued)

Competency	Generalists Ratings	Specialists Ratings	Combined Ratings
11. Demonstrates enthusiasm for teaching and learning and the subject being taught.	.30	.50**	.45**
12. Helps learners develop positive concepts of themselves.	.27	.66***	.61***
13. Manages classroom interactions.	.50**	.49**	.59***
14. Obtains and uses information about the needs and progress of individual learners.	--	--	--
15. Obtains and uses information about the effectiveness of instruction to revise it when necessary.	--	--	--

*p ≤ .05

**p ≤ .01

***p ≤ .001

+N = 6

++N = 7

TABLE 4

Correlation of Factor Scores
and Mean Achievement Gains

Factor	Science Specialists	Generalist	Composite
Management	.61	.50	.61
Learning Environment	.62	.48	.62
Multiple R	.63	.50	.63